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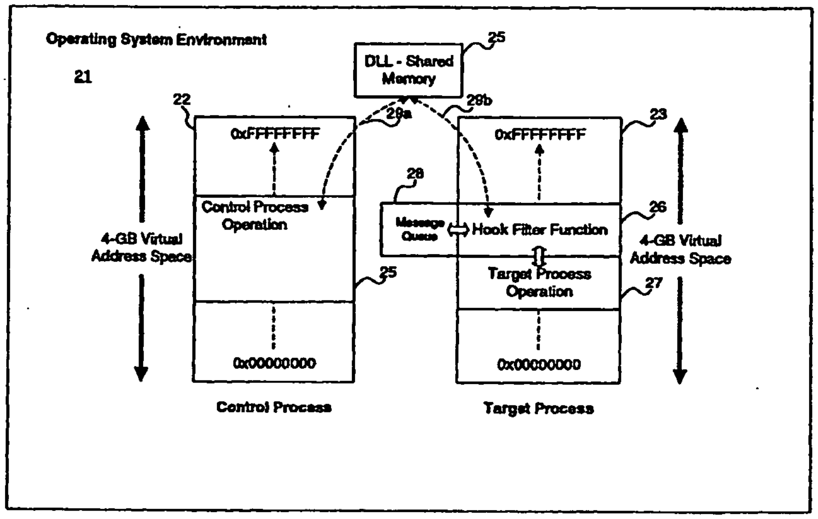

(57) Abstract

Indirect access and control of a target computer process from a control computer process in a multitasking computer operating system environment is described. The control process contains a dynamic linked library (DLL) file. A hook filter function is then inserted into the target process using one of the operating system commands. This forcibly maps the control process DLL into the target process memory space. The hook filter function monitors all messages from the operating system which enter the target process via its message queue. The control process places necessary arguments and data in the DLL and sends a message to the hook filter function requesting an operation within the target process. The hook filter function recognizes the message as being from the control process and that the arguments and data are in the DLL. Data may also be passed from the target process via the DLL to the control process.

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Interface Between a Control Process and a Target Process

Technical Field

The present invention relates to a method of indirectly accessing and controlling one process from another within a multitasking computer operating system environment.

Background Art

In older 16-bit personal computer operating system environments such as Windows 3.1® available from Microsoft Corporation, Redmond, Washington, all running programs—known as processes—share a single virtual address space. Any process can read from and write to memory belonging to any other process, even memory used by the operating system. If a first process inadvertently overwrites data being used by another running second process, the second process could well become unstable and crash. With the advent of 32-bit personal computer operating systems, more virtual address space is available and a more robust environment may be created which avoids this problem.

In some 32-bit computer system operating environments such as Windows 95®, Windows 98®, and Windows NT®, all available from Microsoft Corporation, Redmond, Washington, each process is assigned a unique process address space, typically, 4-GB. Such a process address space contains the executable code and data necessary for the process, that is, the code for the EXE and DLL files and their required data. In addition to an address space, a process also owns certain resources such as files, dynamic memory allocations, and threads. Within a given process, when pointers are used to reference memory, the pointer value refers to a memory address in that process's own assigned memory space. It is not possible for one process to create a pointer which references memory assigned to another process. As a result, the system is stable and robust, and less likely to crash due to memory conflicts. However, it is also very difficult for one process to interact with and affect another.

For example, when a user is prompted for an input by a dialog box, the text from the user is typically stored in an edit control. An edit control is simply a window used to store free-form text input by a user. Within a process, accessing a given edit control is almost trivial. Simply obtaining the handle (or name) of a given edit control window allows access via the operating system's control window messages. However, the most common such control window messages do not work across process boundaries in a 32-bit system with separate virtual address spaces for each process. This is because use of control windows messages typically requires that some message argument parameters be in the form of a memory address of a required data structure. As described above, however, memory addresses are only meaningful within a given process. Thus, user text within an edit control of one process is not available to another process.

To enable a speech recognition system to control a target process when both are running in an advanced 32-bit windowing computer, it is easy if the target application is written with features of the controlling speech recognition system in mind. However, for a speech recognition system to control a target process that is not thus speech-enabled requires utilizing whichever suite of characteristics the target process exhibits in relation to the operating system. These characteristics often make sophisticated control by a speech recognition system, at best, very difficult.

Summary of the Invention

A preferred embodiment of the present invention provides a method for interfacing between a control process and a target process in a multitasking computer operating system environment. The method includes the steps of :

a. establishing a region of shared memory between the control process and the target process;

b. generating a request with the control process for a desired operation by the target process and storing arguments and data for the request in the region of shared memory;

c. communicating the request for the desired operation to the target process; and

d. effecting execution of the desired operation by the target process.

In another embodiment, the method includes:

a. establishing a region of shared memory between the control process and the target process;

b. hooking an executable link module into an address space of the target process;

c. generating a request for a desired operation by the target process and storing arguments and data for the request in the shared memory;

d. posting a private message from the control process to the target process notifying the executable link module of the request;

e. receiving the private message in the executable link module;

f. executing the requested action in the target process; and

g. sending a private message acknowledgment from the executable link module to the control process.

In such an embodiment, the step of receiving may further include retrieving arguments and data for the request from the shared memory. In addition, or alternatively, the step of sending may further include writing new data from the target process into the shared memory. In such an embodiment, the step of sending may further include retrieving the new data by the control process from the shared memory.

A preferred embodiment is also directed to an interface system used between a control process and a target process in a multitasking computer operating system environment. Such a system comprises:

a. a region of shared memory that is established between the control process and the target process;

b. a request generator which generates a request from the control process for a desired operation by the target process and stores arguments and data for the request in the region of shared memory;

c. a request communicator which communicates the request for the desired operation to the target process; and

d. a request receiver which effects execution by the target process of the desired operation.

Another preferred embodiment includes an interface system used between a control process and a target process in a multitasking computer operating system environment. Such a system comprises:

a. a region of shared memory that is established between the control process and the target process;

b. an executable link module hooked into an address space of the target process;

c. a request generator which generates a request for a desired operation by the target process and stores arguments and data for the request in the shared memory;

d. a request communicator which communicates the request for the desired operation to the executable link module;

e. receiving the private message in the executable link module;

f. means for executing the requested action in the target process; and

g. a message acknowledger within the executable link module which sends a message acknowledging receipt and accomplishment of the request by the target process to the control process.

Brief Description of the Drawings

The present invention will be more readily understood by reference to the following detailed description taken with the accompanying drawings, in which:

Fig. 1 illustrates the logical flow associated with a preferred embodiment.

Fig. 2 illustrates the inter-relationships of various functional blocks within the operating system environment according to a preferred embodiment.

Fig. 3 illustrates computer process arrangements in which a preferred embodiment may be employed.

Detailed Description of Specific Embodiments

A preferred embodiment of the present invention, as shown in Figs. 1-3, includes a technique for an originating control process **24** having generally a non-keyboard input **32**, to exchange detailed information with and send commands from a command output block **31** to a separate target process **27**. Such techniques are useful, for instance, where the control process **24** is an automatic speech recognition engine **33** having a speech input **34**, and running in a 32-bit operating system environment **21**, such as Windows NT®, and the target process **27** is a non-speech aware application, such as an e-mail program, running separately in the same operating system environment **21**. It may be desirable for the speech recognition control process **24** to obtain access to and control various forms of data in another target process **27** ranging from simple text to more complex data structures such as in a database file. A preferred embodiment may be advantageously employed in various operating system environments **21**, including, for instance, Windows NT®, Windows 95®, Windows 98®, X for Windows, and UNIX.

A preferred embodiment involves inserting a hook filter function **26** (also known as a callback function) into the target process **27**, and creating a pointer **29b** from the hook filter function **26** to an executable link module in shared system memory, such as a dynamic linked library (DLL) file **25**. A hook filter function **26** is a program mechanism which can intercept events in a process message queue **28** such as messages, keystrokes, and mouse actions before they reach the target process **27**. To operate between separate processes, the filter function invoked by the hook filter function **26** is placed within a DLL **25**. The DLL **25** then allows inter-process communication and control via shared memory within the DLL **25**. Thus, the shared memory **25** is common to the operating system **21** and accessible to both the control process **24** via pointer **29a**, and the target process **27** via pointer **29b**. This technique allows for very efficient transfer of information between the control process **24** and the target process **27**. In addition, the control process **24** may obtain access to information from the target process **27** which is not usually available via inter process communication (IPC), such as user input text in the edit control of a dialog box of a target process **27**. It also allows text from the control process **24**, *e.g.*,the text output from an automatic speech recognition program, to be passed, via the shared memory in the DLL **25**, to an edit control in the target process **27** which treats the text as if it were provided by the user from a keyboard.

Such inter-process text passing to a target process edit control may be considered a short term or an immediately obtainable advantage of a preferred embodiment of the present invention. More prolonged or longer term usefulness may also be realized. For example, the hook filter function **26** may be employed for ongoing monitoring of the operation of the target process **27** for the occurrence of target process events which are of interest to the control process **24**. Such interesting events may include, for example, opening a menu, making a menu selection, or opening a dialog box within the target process **27**.

A preferred embodiment may start with the control process **24** installing a WH_GETMESSAGE hook filter function **26** in the target process **27**, step **11** in Fig. 1. The hook filter function **26** is installed by calling *SetWindowsHookEx* as follows:

```
HHOOK hhook = SetWindowsHookEx(WH_GETMESSAGE, GetMsgProc, hinstDll,
TargetThreadName);
```

The first parameter, WH_GETMESSAGE, indicates the type of hook filter function **26** to install. WH_GETMESSAGE is a hook filter function **26** called when the *GetMessage* or the *PeekMessage* function is about to return a message to the target process **27**. The hook filter function **26** will receive a pointer **29b** to a message structure within the shared memory of the DLL **25** which contains the actual message. The second parameter, *GetMsgProc,* identifies the address of a function in the shared memory of the DLL **25** that the operating system **21** should call whenever a window in the target process **27** is about to process a message in its message queue **28**. The third parameter, *hinstDll*, identifies the DLL **25** that contains the *GetMsgProc* function. In Windows NT, a DLL's *hinstDll* value identifies the 32-bit virtual memory address where the DLL **25** is mapped into the address space **22** of the control process **24**. Since the memory address space of the DLL **25** will be shared by both the control process **24** and the target process **27**, it may be considered accessible to each process via a pointer, **29a** and **29b** respectively. The fourth parameter, TargetThreadName, identifies the thread to hook in the target process **27**. A value of NULL may be passed for the fourth parameter to instruct the operating system **21** to hook all threads in the system.

When *GetMessage* or *PeekMessage* is about to return a message to the target process **27** from the message queue **28**, the operating system **21** checks whether a WH_GETMESSAGE hook **26** is installed on that thread in the target process **27**, and whether the DLL **25** containing the *GetMsgProc* function is mapped into the address space **23** of the target process **27**. If the DLL **25** has not been mapped, the operating system **21** forces the DLL **25** to be mapped into the address space **23** of the target process **27** via pointer **29b** and increments a lock count on the mapping of the DLL **25** in the target process **27**. The operating system **21** looks at the *hinstDll* of the DLL **25** as it applies to the target process **27** and checks to see whether the *hinstDll* of the DLL **25** is at the same location as it applies to the control process **24**. If the *hinstDlls* are the same, the memory address of the *GetMsgProc* function is also the same in the two process address spaces. In such a case, the operating system **21** can simply call the *GetMsgProc* function in the address space **22** of the control process **24**.

If the *hinstDlls* are different, the operating system **21** must determine the virtual memory address of the *GetMsgProc* function in the address space **23** of the target process **27** according to the following formula:

GetMsgProcTarget = hinstDllTarget + (GetMsgProcControl - hinstDllControl)

Subtracting *hinstDllControl* from *GetMsgProcControl* results in the offset in bytes for the *GetMsgProc* function. Adding this offset to *hinstDllTarget* gives the location of the *GetMsgProc* function as it applies to the mapping of the DLL **25** in the address space **23** of the target process **27**. The operating system **21** increments a lock count on the mapping of the DLL **25** in the address space **23** of the target process **27**, and also calls the *GetMsgProc* function in the address space **23** of the target process **27**. When *GetMsgProc* returns, the operating system **21** decrements a lock count on the mapping of the DLL **25** in the target process **27**.

Injecting or mapping the DLL **25** containing the hook filter function **26** maps the whole DLL **25** into the target process **27**, not just the hook filter function **26**. Any and all functions contained in the DLL **25** now exist and can be called from threads running in the context of the target process **27**. For instance, to subclass a window created by a thread in the target process **27**, the WH_GETMESSAGE hook **26** is set on the thread that created the window, and then, when the *GetMsgProc* function is called, call *SetWindowLong* to subclass the window. Of course, the subclass procedure must be in the same DLL **25** as the *GetMsgProc* function.

The hook filter function **26** examines messages in the message queue **28** coming into the target process **27** for messages from the control process **24**. Thereafter, the control process **24**, in step **12**, may generate a request for action or information from the target process **27** and via the pointer **29a** place in the shared memory of the DLL **25** a description of the type of operation requested and any arguments necessary. Then, in step **13**, a message is sent from the control process **24** to the target process **27** notifying the hook filter function **26** of the request from the control function **24**. This message includes an index pointer, **29b** in Fig. 2, to the shared memory location in the DLL **25** where the required information and arguments are available. The hook filter function **26** in the target process **27**, in step **14**, receives the message in the address space **23** of the target process **27**, recognizes the message as a command from the control process **24**, and uses the index pointer **29** to obtain the necessary information and arguments from the shared memory of the DLL **25**, step **15**.

The target process **27**, in step **16**, then makes calls to the operating system **21** accessing the pertinent window to perform the required operation. As a result of this sequence, the control process **24** enjoys the same level of access within the target process **27** as does the target process **27** itself. The control process **24** may thereafter perform any actions within the target process **27** which the target process **27** itself could do. Thus, the message may direct the target process **27** to, for example, move the insertion point, or retrieve text or data from an edit control in the target process **27** and, optionally as in step **17**, write the data to the shared memory of the DLL **25**.

After the control process **24** has sent its initial message to the hook filter function **26**, it waits for notification from the target process **27** that it has accomplished the directed operation. This notification, according to step **18** of Fig. 1, may be accomplished in various manners such as by posting a message in the message queue of the control process **24**, or by changing the state of an event object which managed by the operating system **21** and monitored by the control process **24**. Any text or data from the target process **27** may be posted to the shared memory of the DLL where it may be retrieved by the control process **24**, step **19** of Fig. 1. If the control process **24** no longer requires the use of the hook filter function **26**, the hook filter function **26** may be removed from the target process **27** by the control process **24**. This may be accomplished by use of the *UnhookWindowsHookEx* function.

What is claimed is:

1. A method for interfacing between a control process and a target process in a multitasking computer operating system environment, the method comprising:

a. establishing a region of shared memory between the control process and the target process;

b. generating a request with the control process for a desired operation by the target process and storing arguments and data for the request in the region of shared memory;

c. communicating the request for the desired operation to the target process; and

d. effecting execution of the desired operation by the target process.

2. A method for interfacing between a control process and a target process in a multitasking computer operating system environment, the method comprising:

a. establishing a region of shared memory between the control process and the target process;

b. hooking an executable link module into an address space of the target process;

c. generating a request for a desired operation by the target process and storing arguments and data for the request in the shared memory;

d. posting a private message from the control process to the target process notifying the executable link module of the request;

e. receiving the private message in the executable link module;

f. executing the requested action in the target process; and

g. sending a private message acknowledgment from the executable link module to the control process.

3. A method as in claim 2, wherein the step of receiving further includes retrieving arguments and data for the request from the shared memory.

4. A method as in claim 2, wherein the step of sending further includes writing new data from the target process into the shared memory.

5. A method as in claim 4, wherein the step of sending further includes retrieving the new data by the control process from the shared memory.

6. An interface system used between a control process and a target process in a multitasking computer operating system environment, the system comprising:

a. a region of shared memory that is established between the control process and the target process;

b. a request generator which generates a request from the control process for a desired operation by the target process and stores arguments and data for the request in the region of shared memory;

c. a request communicator which communicates the request for the desired operation to the target process; and

d. a request receiver which effects execution by the target process of the desired operation.

7. An interface system used between a control process and a target process in a multitasking computer operating system environment, the system comprising:

a. a region of shared memory that is established between the control process and the target process;

b. an executable link module hooked into an address space of the target process;

c. a request generator which generates a request for a desired operation by the target process and stores arguments and data for the request in the shared memory;

d. a request communicator which communicates the request for the desired operation to the executable link module;

e. receiving the private message in the executable link module;

f. means for executing the requested action in the target process; and

g. a message acknowledger within the executable link module which sends a message acknowledging receipt and accomplishment of the request by the target process to the control process.

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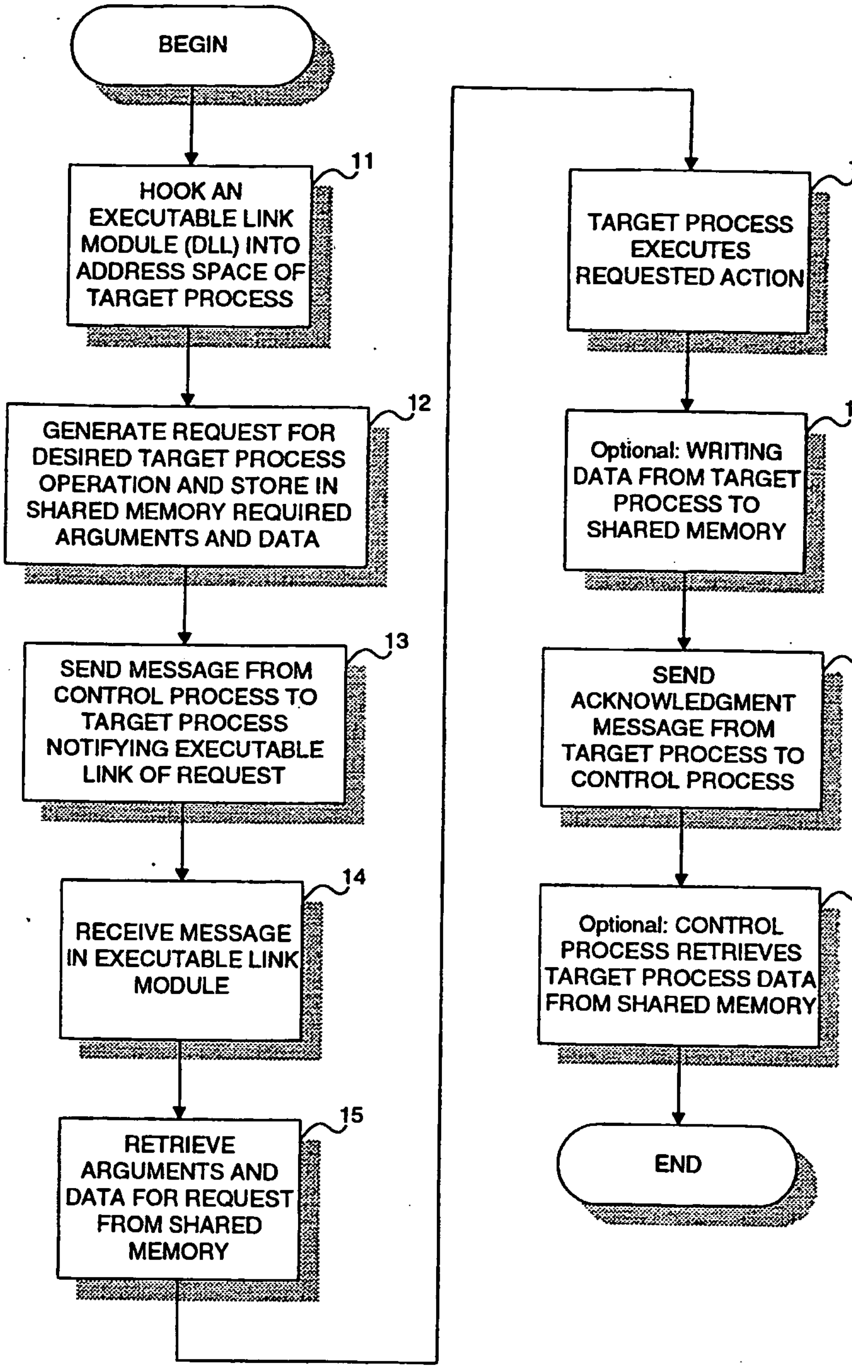
BEGIN
HOOK AN EXECUTABLE LINK MODULE (DLL) INTO ADDRESS SPACE OF TARGET PROCESS
11
GENERATE REQUEST FOR DESIRED TARGET PROCESS OPERATION AND STORE IN SHARED MEMORY REQUIRED ARGUMENTS AND DATA
12
SEND MESSAGE FROM CONTROL PROCESS TO TARGET PROCESS NOTIFYING EXECUTABLE LINK OF REQUEST
13
RECEIVE MESSAGE IN EXECUTABLE LINK MODULE
14
RETRIEVE ARGUMENTS AND DATA FOR REQUEST FROM SHARED MEMORY
15
TARGET PROCESS EXECUTES REQUESTED ACTION
16
Optional: WRITING DATA FROM TARGET PROCESS TO SHARED MEMORY
17
SEND ACKNOWLEDGMENT MESSAGE FROM TARGET PROCESS TO CONTROL PROCESS
18
Optional: CONTROL PROCESS RETRIEVES TARGET PROCESS DATA FROM SHARED MEMORY
19
END

FIGURE 1

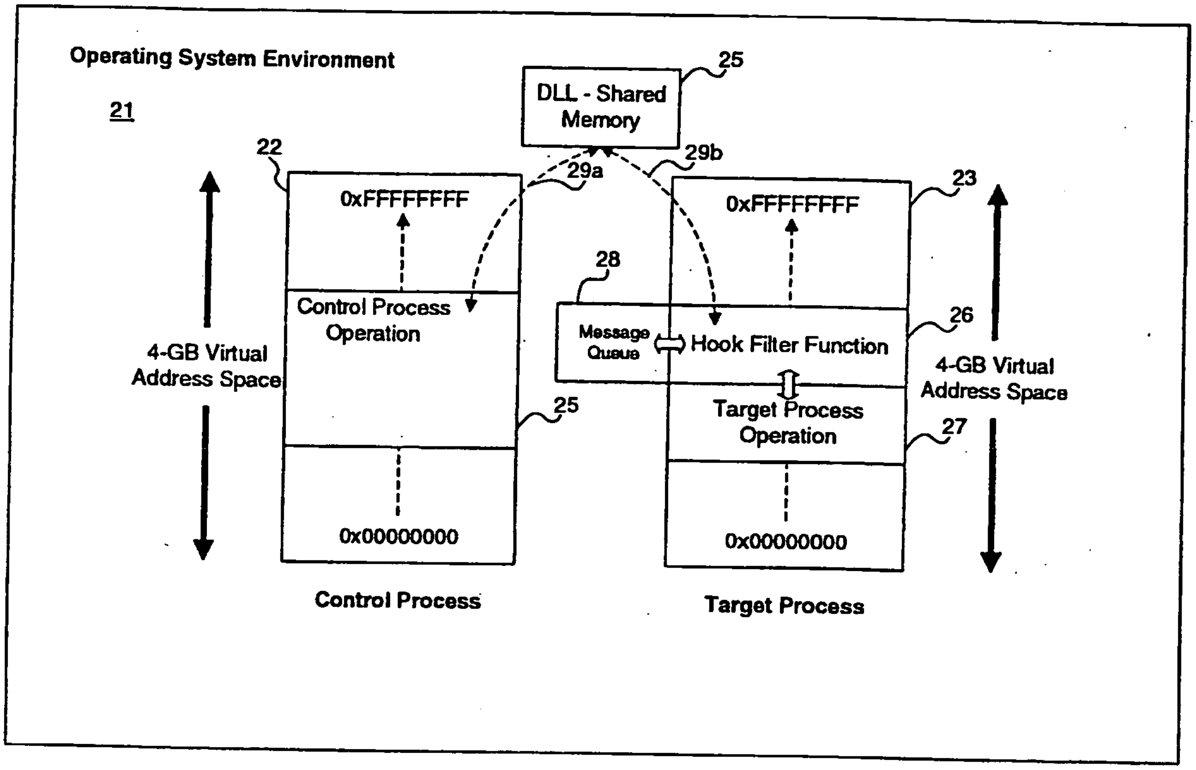
Operating System Environment
21
DLL - Shared Memory
25
22
29a
29b
23
0xFFFFFFFF
0xFFFFFFFF
28
Control Process Operation
Message Queue
Hook Filter Function
26
4-GB Virtual Address Space
4-GB Virtual Address Space
25
Target Process Operation
27
0x00000000
0x00000000
Control Process
Target Process

Figure 2

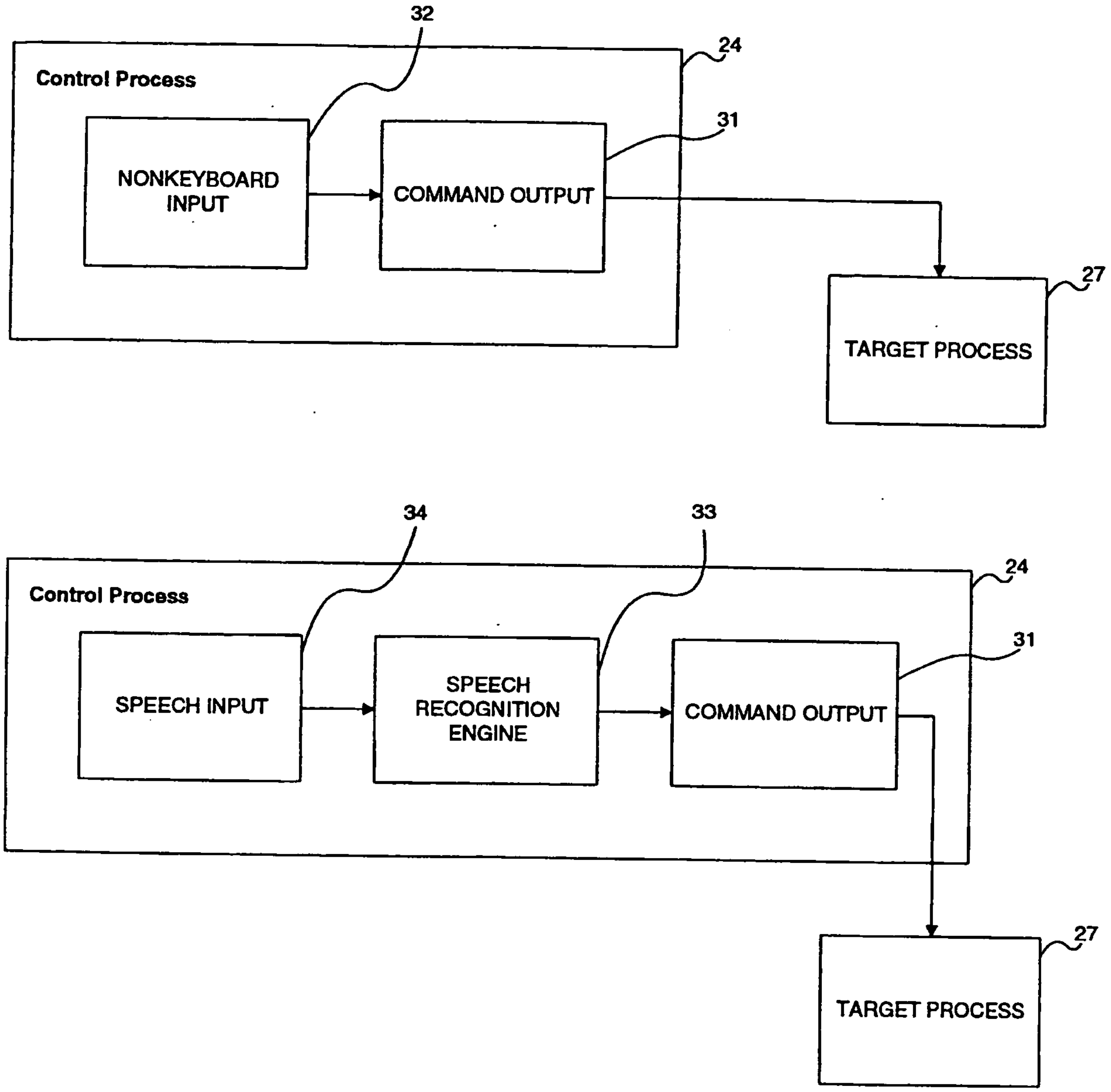
32
24
Control Process
NONKEYBOARD INPUT
COMMAND OUTPUT
31
27
TARGET PROCESS
34
33
24
Control Process
SPEECH INPUT
SPEECH RECOGNITION ENGINE
COMMAND OUTPUT
31
27
TARGET PROCESS

Figure 3

INTERNATIONAL SEARCH REPORT

Intei onal Application No
PCT/US 99/19968

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	EP 0 647 902 A (IBM) 12 April 1995 (1995-04-12) page 3, line 21 -page 5, line 5; figures 1-3 ---	1,6 2-5,7
A	"METHOD FOR IMPLEMENTING DIRECTORY-LIMIT FUNCTIONS IN WINDOWS FILE MANAGER" IBM TECHNICAL DISCLOSURE BULLETIN,US,IBM CORP. NEW YORK, vol. 38, no. 7, July 1995 (1995-07), page 9-10 XP000521585 ISSN: 0018-8689 the whole document --- -/--	2,7

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search 28 January 2000	Date of mailing of the international search report 03/02/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Michel, T

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 99/19968

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	JORDAN D: "INSTANTIATION OF C++ OBJECTS IN SHARED MEMORY" JOURNAL OF OBJECT-ORIENTED PROGRAMMING,US,NEW YORK, NY, vol. 4, no. 1, March 1991 (1991-03), page 21-24,26-28 XP000501371 the whole document -----	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/US 99/19968

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0647902 A	12-04-1995	DE 69418963 D JP 7121373 A US 5737605 A	15-07-1999 12-05-1995 07-04-1998